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3 CLAIMS

4 What is claimed is:

5 1. An aircraft lift control system mounted on an aircraft, the aircraft having at least
6 one wing, the aircraft lift control system comprising:

7 an oscillating aero surface mounted to the aircraft wing;

8 a resonant frame connected to the oscillating aero surface; and

9 an actuator mounted to the resonant frame;

10 wherein the sinusoidal force produced by the actuator on the resonant frame

11 results in a resonant deformation in the resonant frame and resonant-

12 sinusoidal displacement of the aero-surface.

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14 2. The aircraft lift control system of claim 1 wherein the oscillating aero-surface has
15 a width of approximately two (2") inches and a length of approximately one (1") inch,
16 operating at a frequency of approximately 1890 Hz.

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18 3. The aircraft lift control system of claim 1 wherein the oscillating aero-surface
19 operates at a frequency of less than approximately 1000 Hz.

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21 4. The aircraft lift control system of claim 1 wherein the actuator is a linear voice
22 coil actuator.

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24 5. The aircraft lift control system of claim 1 wherein the motive force from the
25 actuator is applied transverse to the motion of the aero-surface such that the sinusoidal
26 force developed by the actuator on the resonant frame results in a resonant rocking
27 motion of the resonant frame, resonant deformation of the columns, and resonant-
28 sinusoidal displacement of the aero-surface.

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6. The aircraft lift control system of claim 1 wherein the aero surface is mounted flush with an upper surface of the aircraft when the actuator is unpowered.
7. The aircraft lift control system of claim 6 wherein acoustic frequency alternating current is transmitted through the voice coil device producing a force, the force varying sinusoidally in time.
8. The aircraft lift control system of claim 7 wherein the frequency of the voice coil alternating current matches the elastic resonance frequency of the resonant frame and oscillating aero-surface mass-spring system thereby resulting in amplitude oscillatory motion of the aero-surface perpendicular to the aircraft wing surface.
9. The aircraft lift control system of claim 8 wherein the top portion of the oscillating aero-surface cyclically projects into the air flowing over the top surface of the wing thereby disturbing the smooth flow over the wing causing local flow separation and vortex structures.
10. The aircraft lift control system of claim 9 wherein the system reduces the vacuum pressure at local points on the wing resulting in a change in the coefficient of lift and change in the pressure moment about the wing which can be used to maneuver the aircraft or to suppress aerodynamic flutter.
11. The aircraft lift control system of claim 6 wherein the oscillating aero-surface returns to a position flush with the upper wing surface upon depowering.
12. The aircraft lift control system of claim 1 and further comprising:
two or more systems within the aircraft wing.

- 1 13. The aircraft lift control system of claim 12 wherein each system is operated
2 independently of the other systems with specific displacement, phase relationship, and
3 operation frequency of the second device is selected to amplify the lift modification
4 effects of the first device.
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- 6 14. The aircraft lift control system of claim 13 wherein a wave-like flow disturbance
7 structure originates at a first device and grows as subsequent effectors cause flow
8 disturbance resonance and the attenuation of the lift effects follows a similar spatial-time
9 pattern with the cyclic displacement of each of the aero-effector devices being actively
10 canceled resulting in a return to smooth flow over the wing.
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- 12 15. The aircraft lift control system of claim 1 wherein the frequency of resonant
13 oscillation is alterable by changes in the resonant frame stiffness of mass distribution.
14
- 15 16. The aircraft lift control system of claim 1 wherein the aero surface is driven
16 through complex displacement waveforms selected from the group consisting of
17 triangular, squarewaves and triangular, and squarewave with partial duty cycles.
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- 19 17. A method for controlling aircraft lift, the aircraft having at least one wing, the
20 method comprising:
21 mounting an oscillating aero surface to the aircraft wing;
22 connecting a resonant frame to the oscillating aero surface;
23 mounting an actuator to the resonant frame; and
24 producing a sinusoidal force on the resonant frame resulting in a resonant
25 deformation in the resonant frame and resonant-sinusoidal displacement of
26 the aero-surface.
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- 28 18. The method of claim 17 wherein the actuator is a linear voice coil actuator.
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- 1 19. The method of claim 17 and further comprising:
2 applying transverse to the motion of the aero-surface such that the sinusoidal force
3 developed by the actuator on the resonant frame results in a resonant
4 rocking motion of the resonant frame, resonant deformation of the
5 columns, and resonant-sinusoidal displacement of the aero-surface.
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- 7 20. The method of claim 17 and further comprising:
8 mounting the aero surface flush with an upper surface of the aircraft when the
9 actuator is unpowered.
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- 11 21. The method of claim 20 and further comprising:
12 transmitting acoustic frequency alternating current through the voice coil device;
13 and
14 producing a force, the force varying sinusoidally in time.
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- 16 22. The method of claim 21 and further comprising:
17 matching the frequency of the voice coil alternating current with the elastic
18 resonance frequency of the resonant frame and oscillating aero-surface
19 mass-spring system thereby resulting in amplitude oscillatory motion of
20 the aero-surface perpendicular to the aircraft wing surface.
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- 22 23. The method of claim 22 and further comprising:
23 projecting the top portion of the oscillating aero-surface cyclically into the air
24 flowing over the top surface of the wing; and
25 disturbing the smooth flow over the wing causing local flow separation and vortex
26 structures.
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- 28 24. The method of claim 23 and further comprising:
29 reducing the vacuum pressure at local points on the wing; and

1 changing the coefficient of lift which can be used to maneuver the aircraft or to
2 suppress aerodynamic flutter.

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4 25. The method of claim 20 and further comprising:
5 returning the oscillating aero-surface to a position flush with the upper wing
6 surface upon depowering.

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8 26. The method of claim 17 and further comprising:
9 providing two or more systems within the aircraft wing.

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11 27. The method of claim 26 and further comprising:
12 operating each system independently of the other systems with specific
13 displacement, phase relationship, and operation frequency of the second
14 device is selected to amplify the lift modification effects of the first device.

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16 28. The method of claim 27 and further comprising:
17 originating a wave-like flow disturbance structure at a first device;
18 increasing the disturbance as subsequent effectors cause flow disturbance
19 resonance and the attenuation of the lift effects follows a similar spatial-
20 time pattern with the cyclic displacement of each of the aero-effector
21 devices being actively canceled resulting in a return to smooth flow over
22 the wing.

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